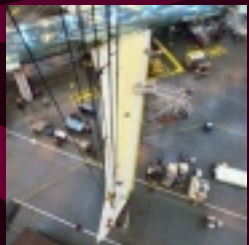
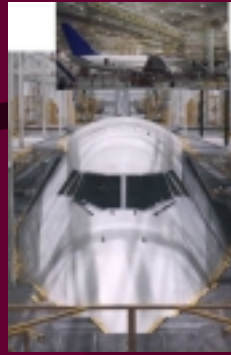


Design for Manufacturing: Jigs & Fixtures in Aircraft Industries

Aircraft Design Project AER814
Ryerson University Feb. 19, 2004



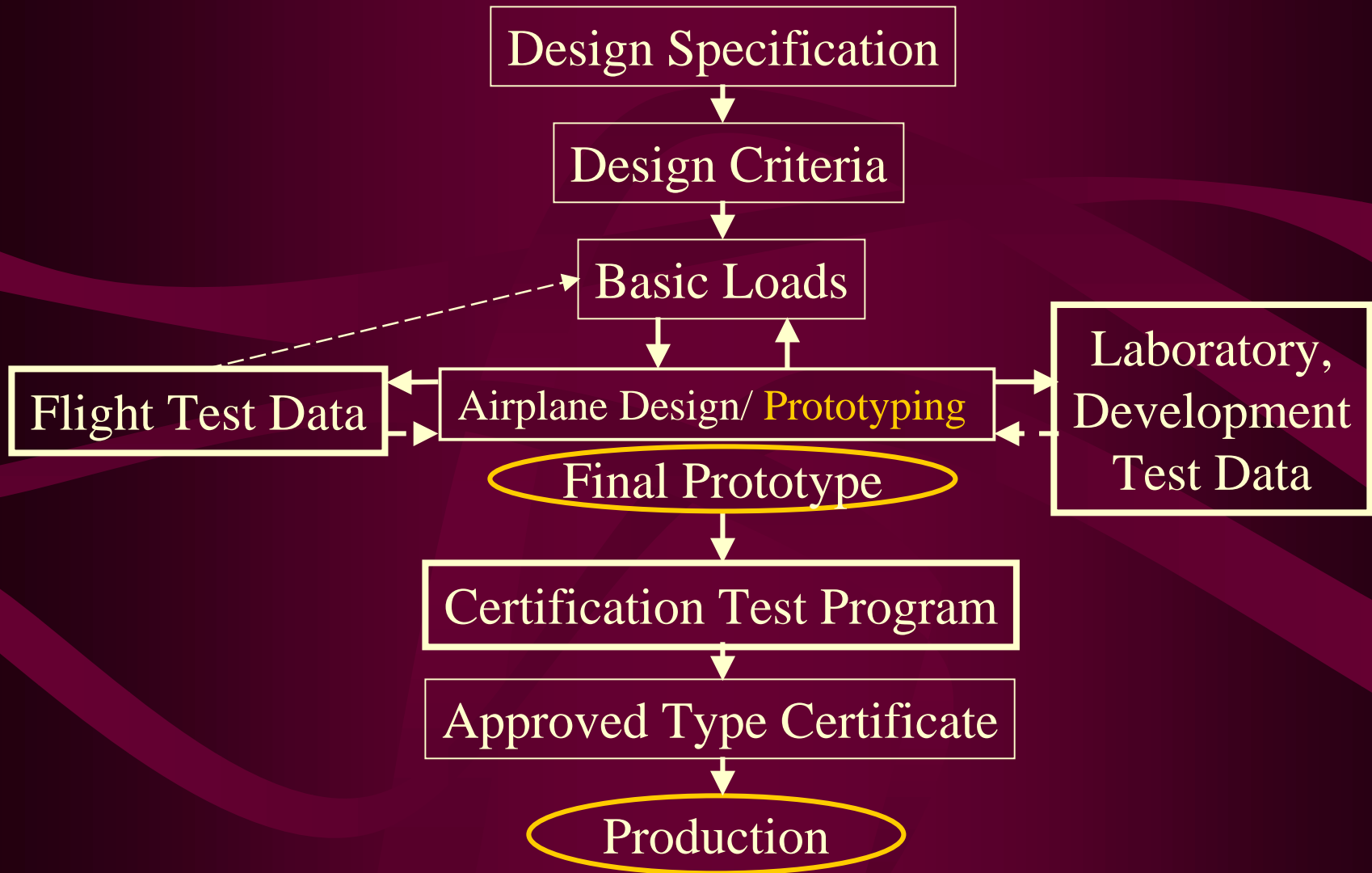
Plan

- Introduction: Airplane Design, Development, Certification and Production
- Design for Manufacturing
- Principles of Producibility Design
- Tools and Manufacturing; Jigs & Fixtures
- Jigs & Fixtures' Advantages in manufacturing
- Jig & Fixture Construction methods and materials
- Jig & Fixture: different types

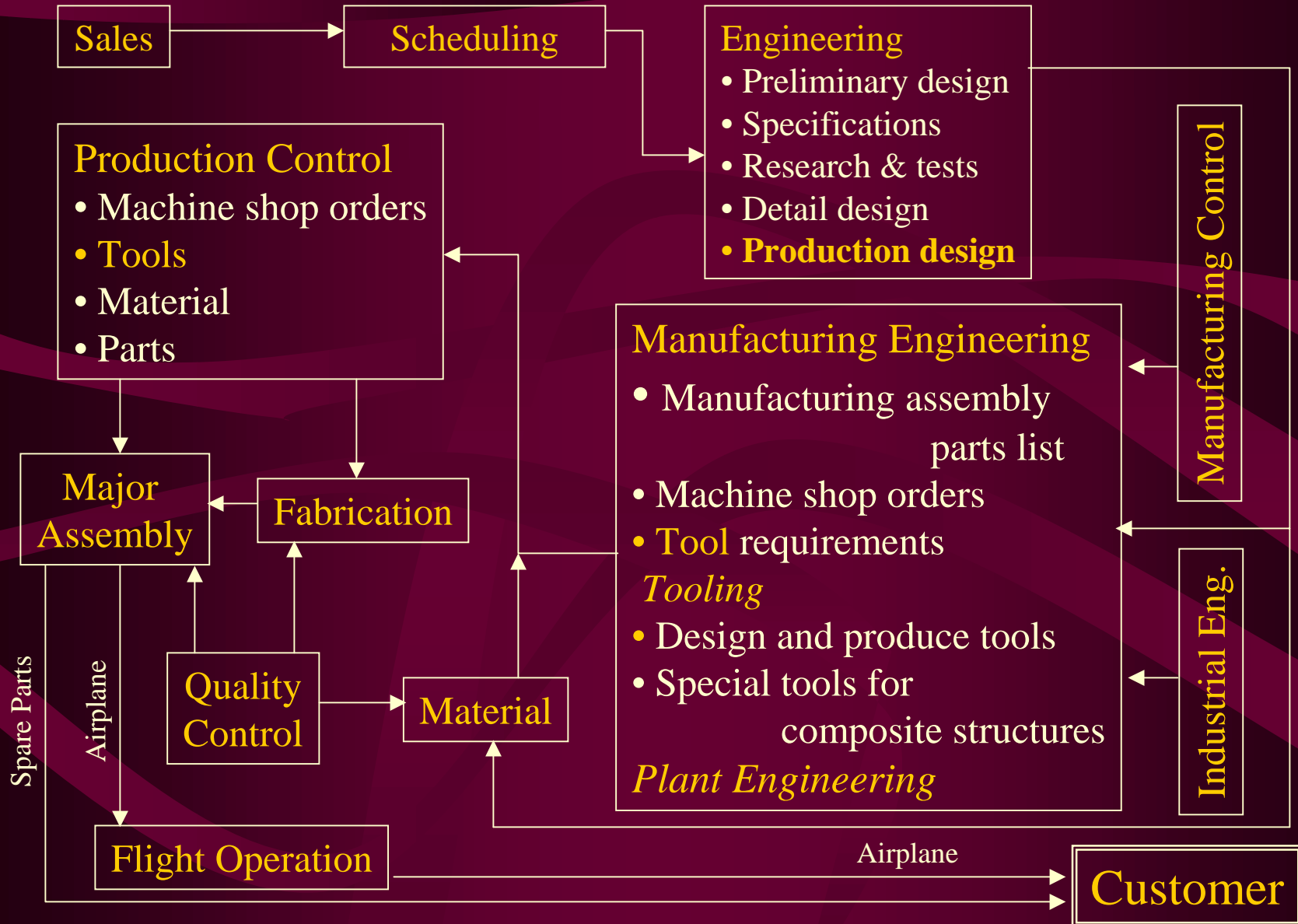
plan

- Jigs & Fixtures: step by step
- Example of assembly fixtures:
 - Boeing 767-400 production line
- Different Jigs & Fixtures; Various examples

Airplane Design, Development, Certification and Production



Design for Manufacturing



Design for Manufacturing (Cont.)

- Design and manufacturing are successive phases of a single operation, the ultimate objective: *an acceptable final product*.
- In aerospace context, such **acceptability** has several components:
 - Market viability,
 - Operational efficiency,
 - Capability for further development,
 - Structural integrity.

Design for Manufacturing (Cont.)

Other important facts are:

- **Maintainability:** Civil airliner, Military aircraft
- **Producibility:** A structure must not be so complex or difficult in concept that its realization will
 - Create great difficulties or
 - Increase the cost of the manufacturing process;
- **Tooling:** Low cost production is possible only by accounting for every possible manufacturing advantages.

Principles of Producibility Design

- (1) General Configuration
- (2) Major breakdowns
- (3) Structure and **Equipment**

Principles of Producibility Design

(1) General Configuration:

- Rectangular vs. tapered wing sections, flaps and control surfaces,
- Minimum number of major structures,
- Cylindrical, straight, or conical surfaces vs. compound curvature,
- Extend of fairing and filleting required;
interchangeability is difficult because of tolerance accumulation, should be used only when essential!

Principles of Producibility Design (Cont.)

(2) Major breakdowns

- Adequate access for assembly,
- Ease of handling and transportation,
- Completeness of master breakdown units,
- Assembly joints,
- Effectiveness:

Improved producibility does not necessarily follow an increase in degree of breakdown!

e.g.; Center wing-box assembled as a single part rather than more subsections

Principles of Producibility Design (Cont.)

(3) Structure and Equipment:

- **Simplicity:** Adequate access for fabrication and subassembly, etc.
- **Parts**
 - Multiple use and Min. number of different parts
 - Min. total number of parts
 - Min. amount and types of attachments
 - Effective use of standard parts, material shape and sizes
- **Detail design:**
 - Interchangeability, Adjustment, Tolerances, Adequate clearances and fastener edge distances, Machining economy, etc. ...

Tools and Manufacturing

- An *aircraft* is conceived as a *complete structure*, but for *manufacturing purposes* must be divided into
 - **Sections**, or main components \implies split into
 - **Sub-assemblies** of decreasing size, resolved into
 - » Individual detail **parts**.
- To build every single part, **special tools** are required!

What is a Fixture?

- A Fixture is a *special tool* used for
 - Locating the work,
 - Clamping the work,
 - Supporting the work,
 - Holding all the elements together in a rigid unit during a manufacturing operation.
- The most important considerations are: *Accuracy* and *rigidity*, followed by *ease of use*, and *economy in construction*.

What is a Jig?

A **Jig** is a type of Fixture with means for positively guiding and supporting tools.

For both Jigs & Fixtures:

- **Origin:** traced back to Swiss watch and clock industry!
- **Objective:** to provide *interchangeability*, *reduction of cost*, and *accuracy* of the manufactured Individual detail Parts, Sub-assemblies, Sections, or main components, and finally the complete structure.

Jigs & Fixtures' Advantages

- Ensure the **interchangeability** and accuracy of parts manufactured,
- Minimize the possibility of human error,
- Permit the use of medium-skilled labor,
- Reduce the manufacturing time,
- Allow the production of repeat orders **without retooling**.

Jig & Fixture: Construction methods and materials

- Cast in iron,
- Fabricated from steel plates, sections and machined parts by
 - welding,
 - Built-up by bolting etc.
- Materials such as
 - Magnesium,
 - Resin, Wood,
 - Plastics and Composite materials, are also used.

Jig & Fixture: different types

- Assembly Fixtures,
- Machining Jigs & Fixtures,
- Drilling Jigs, boring Jigs, etc.
- Welding Fixtures,
- Trim Jigs,
- Control or Master Jig,
- Apply Jig; attaching to a larger jig or an assembly of parts, etc. ...

Jigs & Fixtures: Step by Step

For every part of structure,

- A *mockup* is first designed and is made from material such as wood, plaster, etc.,...
- The mockup is used to design and to build the fixtures ensuring the **contours** and the external form of the structure,
- The *Master Jig* is then designed in order to complete the fixture providing the important **reference points**, Jig and **pin points**, and to provide a **Reference for the regular checks of the fixture**,
- Thermal expansion of fixtures is important!

Boeing 767-400 Assembly line



Floor Beam Tooling



Floor grid



Tail cone



Ergonomic fuselage
turn Fixture



Upper Crown

Boeing 767-400 Assembly line



Boeing 767-400 Assembly line

